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Better Monetary Control May Decrease the Distortion of Stabilisation Policy: A Comment

Abstract

Higher uncertainty about the effects of policy instruments reduces a policymaker's inclination to actively engage in shaping economic policy. If a credibility problem exists, then this is beneficial. However, in the case where the policymaker has private information about an economic shock, higher uncertainty is costly. Hence, the policymaker faces a trade-off when he decides on the degree of control of monetary instruments. It is shown that the optimal degree of uncertainty about the effects of policy depends on the economic preferences of the policymaker and the magnitude of the variance of the shock which is private information.

I. Introduction

An important issue in the conduct of monetary policy revolves around the selection of the monetary operating procedure. In this realm, Swank (1994) has recently analysed the consequences of imperfect control of monetary instruments in the context of a monetary policy game due to Barro and Gordon (1983). In his model, imperfect control stems from the uncertain effects of policy instruments. Brainard (1967) has shown that when the effects of an instrument are surrounded by uncertainty (called multiplicative uncertainty), the policymaker should use the instrument conservatively. Likewise, Swank finds that worse control of the instruments reduces the policymaker's incentive to use the instruments actively and therefore reduces the inflationary bias associated with the conduct of monetary policy. This result implies that from a normative perspective, the policymaker should adopt the most inefficient operating procedure.

Swank's result hinges crucially on the implicit assumption that monetary policy only produces an undesirable inflationary bias. Then any measure

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that induces the policymaker to abstain from the active use of the policy instrument is beneficial. Indeed, a drawback of Swank's model is that it does not allow a policymaker to play a beneficial role. For instance, it does not take into account that monetary instruments can be used to stabilise the economy in response to unforeseen shocks. In this paper we extend Swank's framework to deal with this problem, by assuming that the policymaker has private information about a shock in the economy; cf. Canzoneri (1985). This extension of the model changes Swank's results concerning the optimal monetary policy procedure. In our model the policymaker faces a trade-off when he decides on the degree of control. We show that higher uncertainty about the effects of policy, apart from reducing the inflationary bias of policy, increases the distortion of stabilisation policy. Hence, in our model, monetary control procedures with little uncertainty are optimal if the inflationary bias of policy turns out to be a minor problem (when the policymaker attributes a low priority to pursuing real objectives) and if the stabilisation problem is relatively important (when the shock in the economy about which the policymaker has private information has a high variance). In contrast to Swank, we find that reducing multiplicative uncertainty and therefore gaining information about how the economy works may improve welfare.

Section II is devoted to presenting the model and deriving policy decisions. The optimal control of the operating procedure is derived in Section III.

II. The Model

We begin by presenting a model of monetary policy as developed by Barro and Gordon (1983), which is extended to analyse the consequences of multiplicative uncertainty; cf. Swank (1994). The variables y_t and π_t denote the log of output and inflation. Consider a policymaker who cares about inflation and output. His loss function is given by

$$L = (y_t - ky^*)^2 + s\pi_t^2 \tag{1}$$

where $k > 1$, $s > 0$ and $y^* > 0$. The parameter y^* is the log of the equilibrium rate of output corresponding to the natural rate of employment. The cost that a policymaker attaches to inflating relative to deviations of output from its desired level is measured by s. The working of the economy is described by

$$y_t = y^* + \theta(\pi_t - \pi_t^{\mathrm{e}}) \tag{2}$$

where $\theta > 0$. The superscript e denotes expectations, which are formed by wage setters prior to the realisation of π_t. Equation (2) is commonly used in models of monetary policy that address credibility issues; for a rationale see Cukierman (1992, Ch. 3).

Following Cukierman and Meltzer (1986) and Swank (1994) we assume that the policymaker cannot fully control outcomes. Hence, inflation is determined by

$$\pi_t = \tau_t \pi_t^{\mathrm{p}} + e_t \tag{3}$$

where π_t^{p} is the policy variable. Let $\mathrm{E}(\cdot)$ be the expectations operator. Then, $\mathrm{E}(\tau_t) = 1$, $\mathrm{E}(e_t) = 0$, $\mathrm{var}(\tau_t) = \sigma_\tau^2$, $\mathrm{var}(e_t) = \sigma_{\mathrm{e}}^2$ and $\mathrm{cov}(\tau_t, e_t) = 0$. The variance of τ_t indicates that the effects of the policy variable π_t^{p} are uncertain. We assume that wage setters do not observe τ_t and e_t when they set their nominal wages and determine π_t^{e}. However, the policymaker has private information about e_t when he chooses policy. This information advantage enables the policymaker to play a stabilisation role by accommodating a perceived shock e_t in order to stabilise the price level and output.

Like Cukierman and Meltzer (1986) and Swank (1994) we assume that σ_τ^2 is an institutional feature of the operating procedure chosen by the policymaker. Institutional aspects are less flexible than policy choices. Therefore, we assume that the policymaker chooses σ_τ^2 before the actual policy process takes place and remains fixed during the whole policy game.

Summarising, our policy game consists of five stages. In stage 1 the policymaker determines σ_τ^2. In stage 2 the private sector forms π_t^{e}. In stage 3 the policymaker observes e_t. In stage 4 the policymaker selects π_t^{p}. Finally, in stage 5 τ_t is realised. We solve the game by using backwards induction.

Optimal Policy Decision

Substituting equations (2) and (3) into (1) gives

$$L = \{\theta(\tau_t \pi_t^{\mathrm{p}} + e_t - \pi_t^{\mathrm{e}}) - (k-1)y^*\}^2 + s\{\tau_t \pi_t^{\mathrm{p}} + e_t\}^2. \tag{4}$$

When the policymaker determines π_t^{p}, he knows the forecast e_t. However, he has no information about the variable τ_t. Hence, he selects π_t^{p} by minimising $\mathrm{E}_{\mathrm{pm}}(L)$, where $\mathrm{E}_{\mathrm{pm}}(L)$ indicates that expectations of L are taken with respect to τ_t. Using the stochastic properties of the variable τ_t, we obtain

$$\pi_t^{\mathrm{p}} = \frac{\theta(k-1)y^* - (\theta^2 + s)e_t + \theta^2 \pi_t^{\mathrm{e}}}{(\theta^2 + s)(1 + \sigma_\tau^2)}. \tag{5}$$

We denote the inflation rate that the private sector expects by π_t^{e}. The private sector knows that inflation is determined by equation (3), but does not have information about e_t and the variable τ_t. Hence, $\pi_t^{\mathrm{e}} = \mathrm{E}(\pi_t^{\mathrm{p}})$. It follows straightforwardly that

$$\pi_t^{\mathrm{e}} = \frac{\theta(k-1)y^*}{s(1+\sigma_\tau^2)+\theta^2\sigma_\tau^2} \equiv K. \tag{6}$$

Substituting (6) into (5) gives

$$\pi_t^{\mathrm{p}} = K - \frac{e_t}{1+\sigma_\tau^2}. \tag{7}$$

As is usual in models of monetary policy, the optimal discretionary choice of π_t^{p} contains an inflationary bias, K. Equation (6) shows that K decreases if σ_τ^2 increases, leading to lower inflation. However, the second term on the r.h.s. of (7) indicates that a rise in σ_τ^2 also distorts stabilisation policy, since then the response to e_t decreases (in absolute value). These results reflect that an instrument should be used conservatively if its consequences are uncertain; cf. Brainard (1967). In the Appendix we show that:

$$\mathrm{var}(\pi_t) = \sigma_\tau^2 K^2 + \sigma_e^2 \frac{\sigma_\tau^2}{1+\sigma_\tau^2} \tag{8}$$

$$\mathrm{var}(y_t) = \theta^2\, \mathrm{var}(\pi_t). \tag{9}$$

Equations (8) and (9) reveal that inflation and output are partly stabilised by the policymaker, since only a part of the variance of e_t (i.e. σ_e^2) appears. For both variances, we find that the lower σ_τ^2, the better the stabilisation.

III. Optimal Instrument Control

We now derive the optimal degree of instrument control; cf. Cukierman and Meltzer (1986) and Swank (1994). We derive the unconditional expected value of the policymaker's loss function: L^*. This function takes into account the policy formation process as discussed in Section II and is based on taking expectations with respect to τ_t, and e_t. Using (1), (8), (9) and that $\mathrm{E}(z^2) = \mathrm{var}(z) + \mathrm{E}(z)^2$, we obtain

$$\begin{aligned} L^* &= (k-1)^2(y^*)^2 + \mathrm{var}(y_t) + s\,\mathrm{var}(\pi_t) + sK^2 \\ &= (k-1)^2(y^*)^2 + (s+\theta^2)\left\{\sigma_\tau^2 K^2 + \sigma_e^2 \frac{\sigma_\tau^2}{1+\sigma_\tau^2}\right\} + sK^2 \end{aligned} \tag{10}$$

where K is given by equation (6). In the Appendix we show

$$\operatorname{sgn}\left(\frac{\partial L^*}{\partial \sigma_\tau^2}\right) = \operatorname{sgn}[s - c + (s + \theta^2 - c)\sigma_\tau^2] \tag{11}$$

where $c = [\theta(k-1)y^*]/\sigma_e > 0$. We distinguish three cases: (I) $c > s + \theta^2$; (II) $s < c < s + \theta^2$; and (III) $c < s$. Comparing case (I) with case (III) and using the definition of c shows that case (I) represents a situation where σ_e^2 and s are relatively low and where $(k-1)y^*$ is relatively high. Hence, in case (I) the credibility problem is comparatively important since K is high, whereas interests to stabilise in response to the shock e_t are relatively small, because σ_e^2 is low. Case (III) describes the opposite situation. Case (II) is intermediate. The following proposition shows the consequences of changing the efficiency of the operating procedure (σ_τ^2).

Proposition A.

(AI) *If case (I) applies, $\partial L^*/\partial \sigma_\tau^2$ is always negative.*

(AII) *If case (II) applies, $\partial L^*/\partial \sigma_\tau^2$ is negative for $0 \le \sigma_\tau^2 < x$ and positive for $x \le \sigma_\tau^2$ where*

$$x = \frac{c - s}{s + \theta^2 - c} > 0.$$

(AIII) *If case (III) applies, $\partial L^*/\partial \sigma_\tau^2$ is always positive.*

In stage 1 of the policy game we described in Section II, the policymaker selects the control of the operating procedure, σ_τ^2. Obviously, in case (III) the policymaker adopts an operating procedure which is precise ($\sigma_\tau^2 = 0$). The benefits from dealing with the credibility problem are lower than the benefits of better stabilisation of the economy. The opposite applies to case (I). In the intermediate case (II) the policymaker prefers to choose $\sigma_\tau^2 = x$. The discussion is summarised in proposition B where $\sigma_\tau^2{}^*$ denotes the optimal value for σ_τ^2.

Proposition B.

(BI) *If case (I) applies, then $\sigma_\tau^2{}^* = \infty$*

(BII) *If case (II) applies, then $\sigma_\tau^2{}^* = x$*

(BIII) *If case (III) applies, then $\sigma_\tau^2{}^* = 0$.*

Proposition B indicates that adopting a control mechanism for inflation which is not too precise is optimal when case (I) or (II) applies. In our model, imperfect monetary control may be desirable because multiplicative uncertainty reduces the inclination to actively use the monetary instrument; cf. Swank (1994). Therefore, as in Cukierman and Meltzer (1986), our model shows that ambiguous control procedures may be desirable. However, the incentive to adopt imperfect monetary control stems from a different source. In Cukierman and Meltzer's model, private information is the main reason why a policymaker would like to adopt ambiguous control procedures, since this improves the policymaker's ability to preserve an information advantage concerning his goals. However, in our model, private information reduces the policymaker's inclination to adopt procedures which are imprecise. Hence, the role of private information differs. Our results are more intuitive than those of Swank. In our model the optimal σ_τ^2 may be finite and as low as technologically feasible, whereas in Swank's model $\sigma_\tau^2{}^*$ is infinite.

The desired degree of multiplicative uncertainty depends on whether case (I), (II) or (III) prevails according to proposition B. This implies that $\sigma_\tau^2{}^*$ is related to the degree of inflation aversion (s), the variance of $e_t(\sigma_e^2)$ and the output gap: $(k-1)y^*$. In the Appendix we show that the desired degree of multiplicative model uncertainty is related to the parameters of the model as follows. First, the higher the variance of the shock e_t, the lower the preferred uncertainty concerning the effects of policy instruments. Second, the desired degree of multiplicative uncertainty tends to be lower if the policymaker becomes less interested in pursuing real objectives (higher s or lower $(k-1)y^*$). Summarising:

Proposition C. *The optimal value for σ_τ^2 tends to decrease as σ_e^2 increases, s* increases and $(k-1)y^*$ *decreases.*

Appendix

Derivation of Equations (8) and (9)

Inflation is determined by (3). The unconditional expected value of inflation can be derived using the equilibrium rate of inflation (equation (7)) and the stochastic properties of e_t and τ_t. This yields $\mathrm{E}(\pi_t) = K$. Hence, the unconditional variance of π_t equals $\mathrm{var}(\pi_t) = \mathrm{E}(\pi_t - K)^2$. Using (7) we obtain

$$\begin{aligned}\mathrm{var}(\pi_t) &= \mathrm{E}(\tau_t(K - e_t/(1+\sigma_\tau^2)) + e_t - K)^2 \\ &= \mathrm{E}(K(\tau_t - 1) + e_t(1+\sigma_\tau^2 - \tau_t)/(1+\sigma_\tau^2))^2. \qquad \text{(A1)}\end{aligned}$$

Since τ_t and e_t are independently distributed and $\mathrm{E}(1+\sigma_\tau^2 - \tau_t)^2 = (1+\sigma_\tau^2)\sigma_\tau^2$, we find

$$\mathrm{var}(\pi_t) = \sigma_\tau^2 K^2 + \sigma_e^2 \frac{\sigma_\tau^2}{1+\sigma_\tau^2}. \qquad \text{(A2)}$$

Using that output is determined by $y_t = y^* + \theta(\pi_t - \pi_t^e) = y^* + \theta(\pi_t - K)$, we find $\mathrm{E}(y_t) = y^*$. Then

$$\mathrm{var}(y_t) = \mathrm{E}(\theta(\pi_t - \pi_t^e))^2 = \theta^2 \mathrm{E}(\pi_t - K)^2 = \theta^2 \mathrm{var}(\pi_t). \qquad \text{(A3)}$$

Derivation of Equation (11)

Differentiating (10) with respect to σ_τ^2 yields

$$\frac{\partial L^*}{\partial \sigma_\tau^2} = \left\{\frac{(s+\theta^2)\,\sigma_e^2}{(1+\sigma_\tau^2)^2}\right\} + 2\,\frac{\partial K}{\partial \sigma_\tau^2}\,[s+\sigma_\tau^2(s+\theta^2)]\,K + (s+\theta^2)\,K^2. \tag{A4}$$

Since

$$\frac{\partial K}{\partial \sigma_\tau^2} = \frac{-K(s+\theta^2)}{s\,(1+\sigma_\tau^2)+\theta^2\,\sigma_\tau^2} \tag{A5}$$

we obtain, after some rearrangements and using K (see equation (6)):

$$\frac{\partial L^*}{\partial \sigma_\tau^2} = \left\{\frac{\sigma_e^2}{(1+\sigma_\tau^2)^2} - \frac{(\theta(k-1)\,y^*)^2}{\{s(1+\sigma_\tau^2)+\theta^2\sigma_\tau^2\}^2}\right\}(s+\theta^2) \tag{A6}$$

Using $c = [\theta\,(k-1)\,y^*]/\sigma_e$, (A6) can be rewritten as

$$\frac{\partial L^*}{\partial \sigma_\tau^2} = \left\{\frac{\sigma_e^2}{(1+\sigma_\tau^2)^2} - \frac{c^2\,\sigma_e^2}{\{s(1+\sigma_\tau^2)+\theta^2\sigma_\tau^2\}^2}\right\}(s+\theta^2)$$

$$= \sigma_e^2\left\{\frac{1}{(1+\sigma_\tau^2)} - \frac{c}{\{s(1+\sigma_\tau^2)+\theta^2\sigma_\tau^2\}}\right\}$$

$$\times\left\{\frac{1}{(1+\sigma_\tau^2)} + \frac{c}{\{s(1+\sigma_\tau^2)+\theta^2\sigma_\tau^2\}}\right\}(s+\theta^2) \tag{A7}$$

Hence, the sign of the first-order derivative is given by the first term in brackets since the other terms are strictly positive. After some rearrangements it can be shown that

$$\operatorname{sgn}\left(\frac{\partial L^*}{\partial \sigma_\tau^2}\right) = \operatorname{sgn}\{s\,(1+\sigma_\tau^2)+\theta^2\,\sigma_\tau^2 - c\,(1+\sigma_\tau^2)] = \operatorname{sgn}[s-c+(s+\theta^2-c)\,\sigma_\tau^2]. \tag{A8}$$

Proof of Proposition C

Suppose that case III applies. Then $\sigma_\tau^2{}^* = 0$. If s and σ_e^2 decrease and $(k-1)\,y^*$ increases then, at a certain point, case II starts to apply and x is the optimal value of σ_τ^2. Since $x>0$, $\sigma_\tau^2{}^*$ rises. Moreover,

$$\frac{\partial x}{\partial s} = \frac{-\theta^2}{(s+\theta^2-c)^2} < 0, \tag{A9}$$

$$\frac{\partial x}{\partial c} = \frac{\theta^2}{(s+\theta^2-c)^2} > 0, \tag{A10}$$

Since $\partial c/\partial\sigma_e < 0$ and $\partial c/\partial((k-1)\,y^*) > 0$, we obtain that $\partial x/\partial\sigma_e < 0$ and $\partial x/\partial((k-1)\,y^*) > 0$. Hence, when s and σ_e^2 continue decreasing and $(k-1)\,y^*$

continues increasing, x rises and therefore $\sigma_\tau^2{*}$ increases. At some point case II ceases to hold and then case I applies, where $\sigma_\tau^2{*} = \infty$. Because $x < \infty$, we conclude that proposition C summarises this discussion.

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